

Ultrasound Evaluation of Ankle and Foot Pathology

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Disclosures

- Consultant: Bioclinica
- Book Royalties: Elsevier
- Contractor: POCUS PRO
- Advisory Board: Philips
- Not relevant to this talk

Syllabus and other educational material can be found at www.jacobsonmuskus.com

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Outline

- Trauma:
 - Tendon, Ligament, Bone
- Infection and Inflammation
- Developmental Anomalies
- Tumors and Tumor-like Abnormalities

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Trauma: tendon

- Overuse, degenerative etiology
 - Specific locations
- Acute injury
 - Avulsions
- Penetrating injury



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Suggested Classification System

- Tenosynovitis: paratenon inflammation
- Tendinosis: tendon degeneration
- Tendon tear
 - Partial-thickness
 - Full-thickness tear

Khoury NJ et al.
MRI of posterior tibial tendon dysfunction
AJR 1996; 167:675

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Tibialis Posterior Tendon:

- Medial malleolus
 - Longitudinal split
 - Complete tear: rheumatoid arthritis
 - Subluxation: retinaculum injury
- Navicular
 - Avulsions: diabetic

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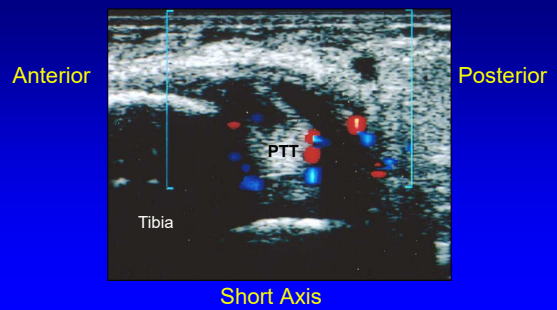
Tenosynovitis:

- Inflammation of paratenon
- Surrounding fluid
 - Up to 3 mm may be physiologic
- Synovial proliferation
- Tendon may be normal
- Inflammatory or reactive

Radiographics 1998; 18:325

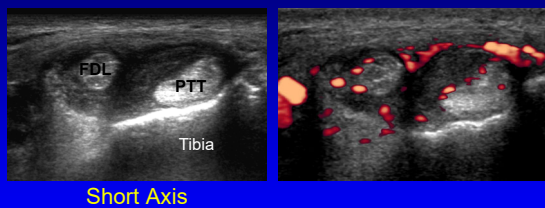
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Tenosynovitis: tibialis posterior tendon



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Tenosynovitis: ankylosing spondylitis



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Pitfall: *communicating ankle effusion*

- Flexor hallucis longus tendon sheath
- Less common: other medial tendons
- Peroneal tendons: indicates calcaneofibular ligament tear
- No pain or hyperemia

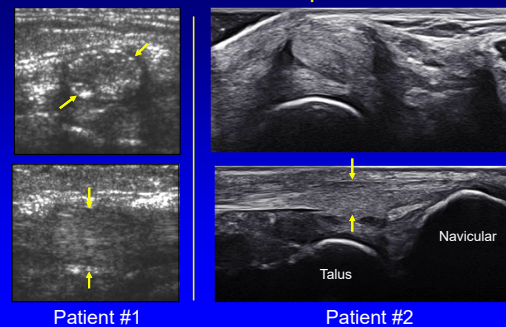
10

Tendinosis:

- Tendon degeneration
- Not tendinitis: no acute inflammation
- Swollen, hypoechoic tendon
- Unlike tear:
 - Tendon fibers still continuous
 - No defined clefts

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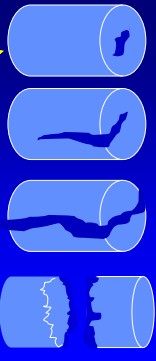
Tendinosis: tibialis posterior



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Tendon Tear Terminology

- Partial-thickness:
 - Interstitial or
 - Extends to one surface
- Full-thickness, incomplete:
 - Extends to two surfaces
 - i.e. longitudinal split
- Full-thickness, complete:
 - Entire tendon discontinuous



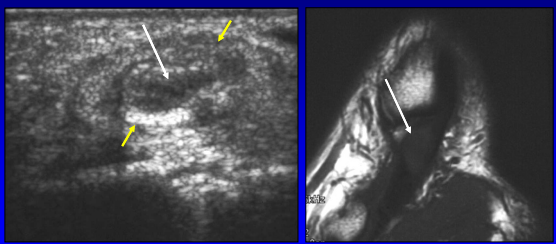
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Partial-thickness Tendon Tear:

- Hypoechoic or anechoic
- Abnormal tendon morphology
- Enlarged or thinned
- Intrastance tear or tear extending to one tendon surface

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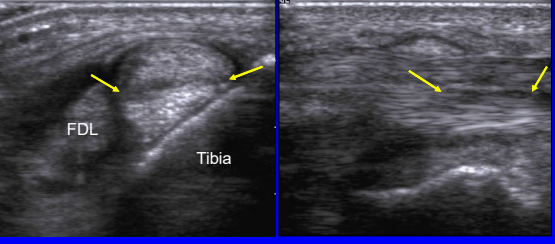
Intrastance Tear: tibialis posterior



Short Axis Sagittal T1w

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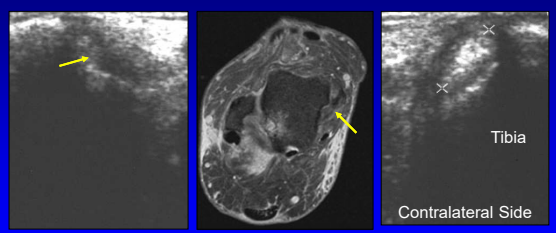
Longitudinal Split: tibialis posterior



Short Axis Long Axis

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Full-thickness Tear: tibialis posterior



Short Axis

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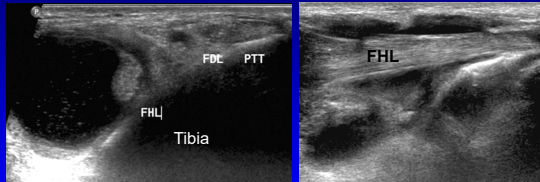
Flexor Hallucis Longus Tendon:

- Stenosing tenosynovitis
 - Behind medial malleolus
 - Level of os trigonum
 - Between hallux sesamoids
- Tears: lacerations > spontaneous
 - Longitudinal split: Knot of Henry

Boruta. Foot Ank Int 1997; 18:243

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Tenosynovitis: flexor hallucis longus



Short Axis

Long Axis

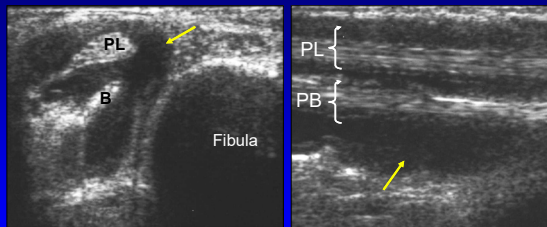
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Peroneal Tendons:

- Lateral malleolus
 - Longitudinal split, complete tear
 - Subluxation: retinaculum injury
- Os peroneum: peroneus longus
 - Complete tear, os peroneum fracture
- 5th metatarsal: peroneus brevis
 - Avulsion, with aponeurosis

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Tenosynovitis: peroneal tendons



Short Axis

Long Axis

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Peroneal Tendon Pathology:

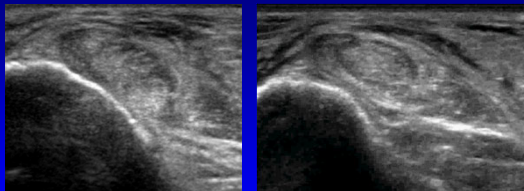
Retrospective: 40 patients with surgery:

- 88% peroneus brevis tear
- 37% peroneus brevis + longus tears
- 33% low lying peroneus brevis muscle
- 20% tendon subluxation
- 13% peroneus longus tear

J Foot Ankle Surg 2003; 42:250

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Peroneus Brevis Split Tear



Short Axis

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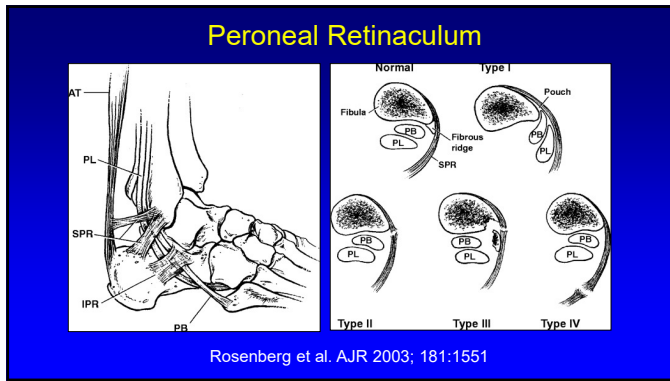
Peroneal Tendon Tears: US

- 54 tendons (5 peroneal): surgery
 - US: 100% sensitivity, 93% accuracy¹
- 60 peroneal tendons: surgery
 - US: 100% sensitivity, 90% accuracy²

¹Waitches et al. JUM 1998; 17:249

²Grant et al. 2005; 87:1788

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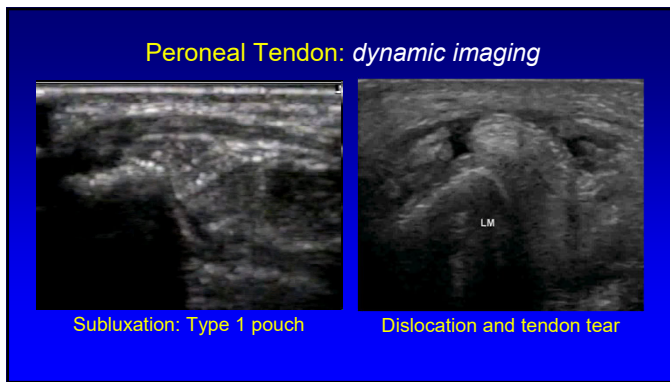
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Peroneal Tendon Subluxation:

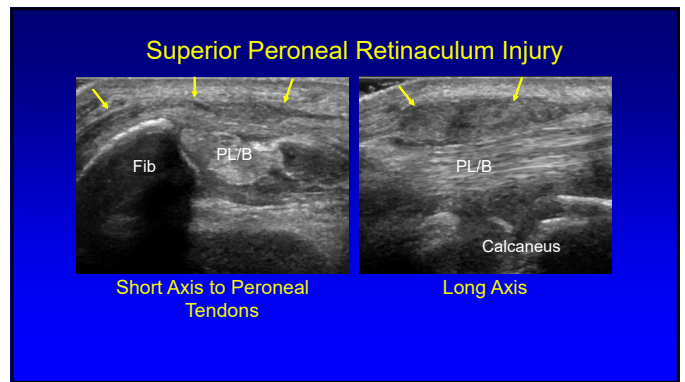
- Abnormal movement may only occur dynamically
- Predisposes to peroneal tendon tears
 - Longitudinal split of peroneus brevis
- US: examine with dorsiflexion / eversion
 - 100% accurate diagnosis with US

Neustadter et al. AJR 2004; 183:985

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Intrasheath Peroneal Subluxation

- Abnormal snapping: peroneal tendons
- No lateral displacement, intact retinaculum
- Type A: no tear; B: tendon tear
- Associations:
 - Convex posterior fibula in 92%
 - Tendon tear in 86%
 - Low lying peroneus brevis muscle in 71%

J Bone Joint Surg Am 2008; 90:992
 J Foot Ankle Surg 2009; 48:323

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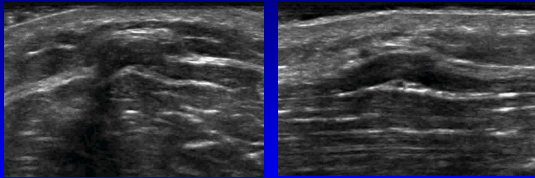
Muscle Hernia

- Cause: trauma, activities, weak fascia
- Lower leg: especially anterior tibialis
- Swelling with muscle contraction
- US: muscle bulge, possible fascial defect
 - Site of perforating vessel

Beggs, AJR 2003; 180:395

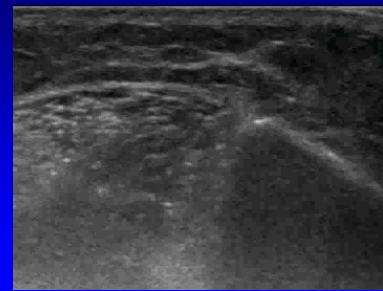
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Muscle Hernia: anterior tibialis



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Muscle Hernia: anterior tibialis



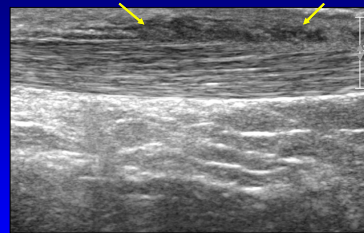
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Achilles Tendon:

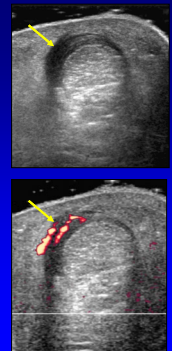
- 2 – 6 cm proximal to insertion
 - Tendinosis
 - Full-thickness tear
- Calcaneal attachment
 - Tendinosis, tear
 - Haglund Syndrome

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Paratenonitis: Achilles

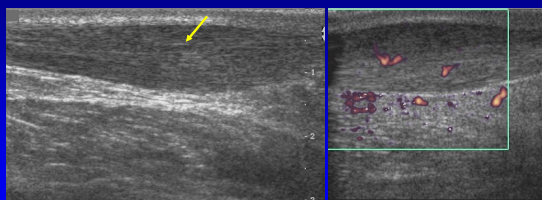


Longitudinal



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Tendinosis: Achilles

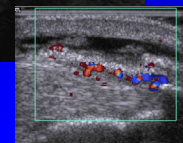
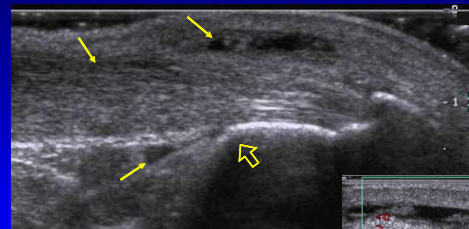


Long Axis

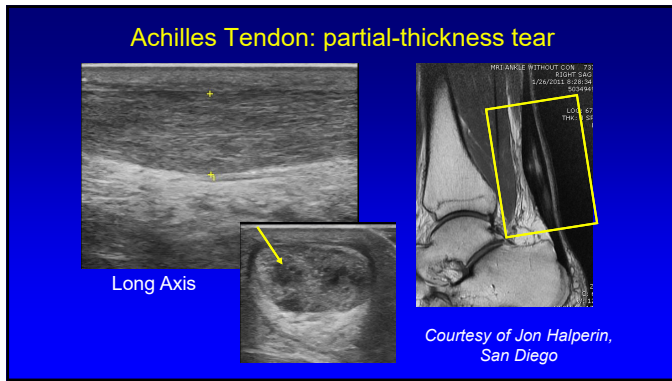
power Doppler

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Haglund Syndrome



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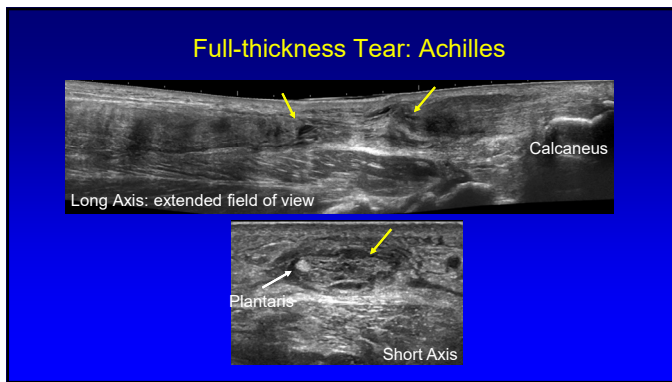
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Achilles Tendon: *complete tear*

- Full-thickness fiber disruption
- Herniation of hyperechoic fat into tendon gap
- Posterior shadowing at torn tendon ends¹
- Non-surgical management:²
 - >5 mm diastasis: worse outcomes
 - >10 mm diastasis: higher re-tear rate

¹Hartgerink, P et al. Radiology 2001; 220:406
²Westin, O et al. Ortho J Sports Med 2016; Oct 2016

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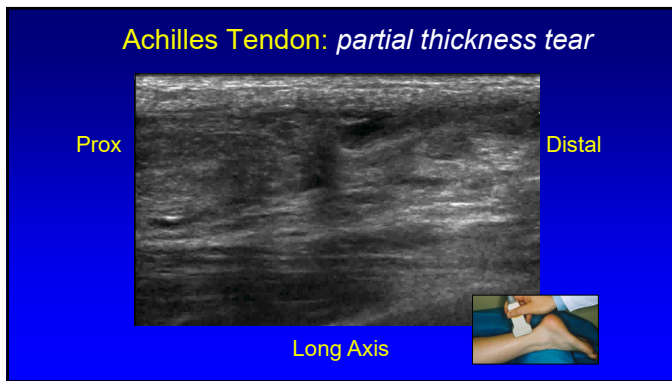
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Achilles Tendon: *complete tear*

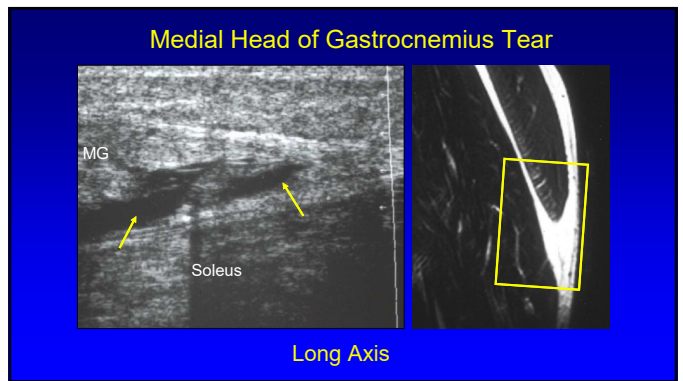
- Pitfall: misinterpretation of intact plantaris as Achilles fibers
- Dynamic imaging: look for
 - Widening of gap with passive dorsiflexion
 - Lack of tendon movement across tear
 - Determine if ends approximate

Long Axis

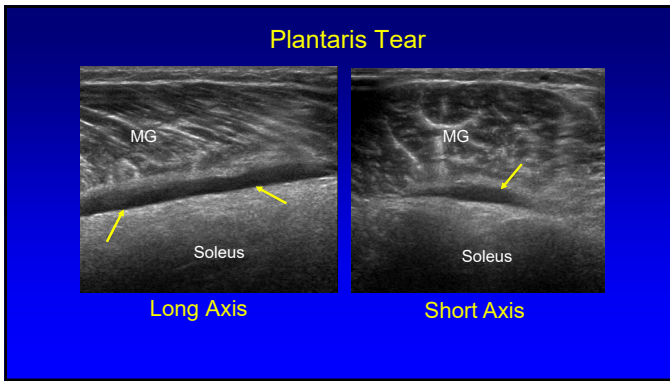
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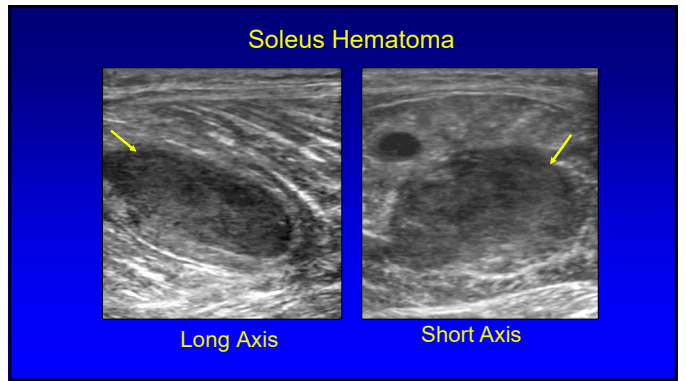
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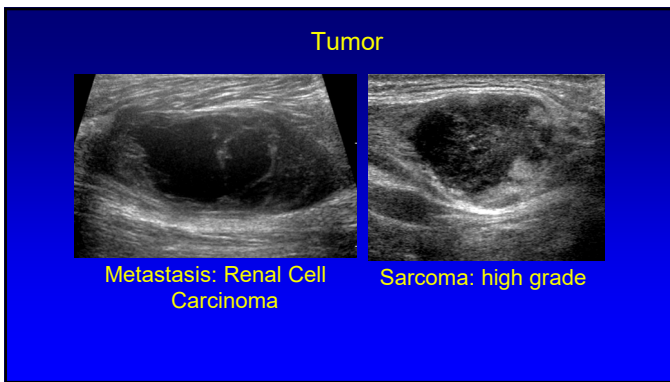
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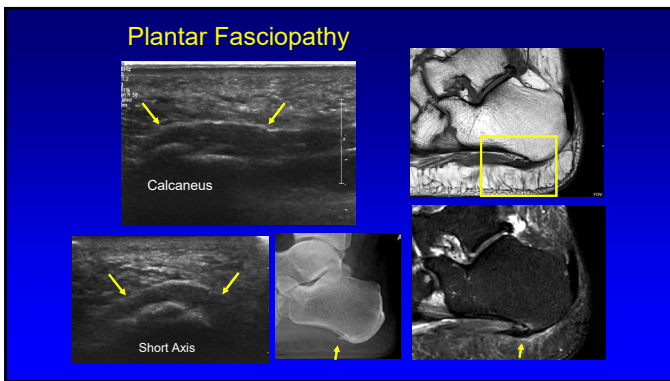
Plantar Fascia

- Fasciopathy
 - Central cord, proximal
 - Degenerative, tendinosis-like
- US:
 - Hypoechoic, thickened > 4 mm
 - Painful with transducer pressure

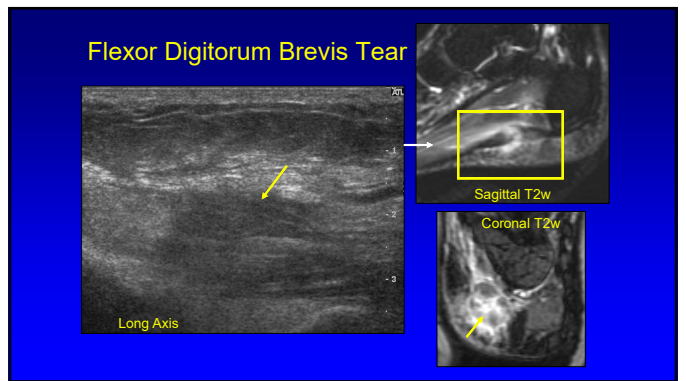
From: Moraes do Carmo; Skeletal Radiol 2008; 37:929

Cardinal, E. et al. Radiology 1996; 201:257

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Outline

- Trauma:
 - Tendon, Ligament, Bone
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Ligament Tear:

- Hypoechoic & thickened
- Acute: anechoic fluid tracking through defect indicates full-thickness tear
- Cortical avulsion: hyperechoic

50

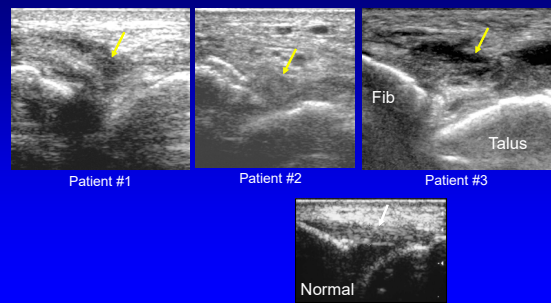
Trauma: ligament

- Lateral:
 - Anterior talofibular: isolated tear in 66%
 - Calcaneofibular
 - 20% calcaneofibular + anterior talofibular
 - Posterior talofibular: dislocation
 - Anterior tibiofibular: high ankle sprain

Helgason. Radiol Clin N Am 1998; 36:729

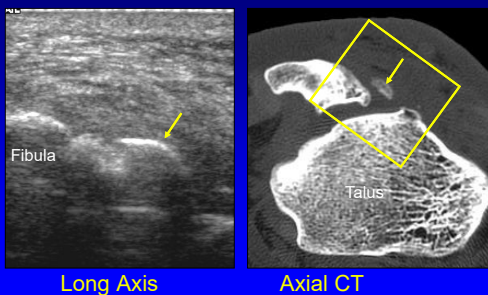
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Anterior Talofibular Ligament Tear



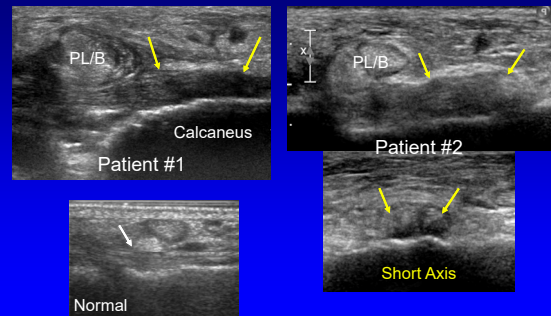
52

Anterior Talofibular Ligament: avulsion

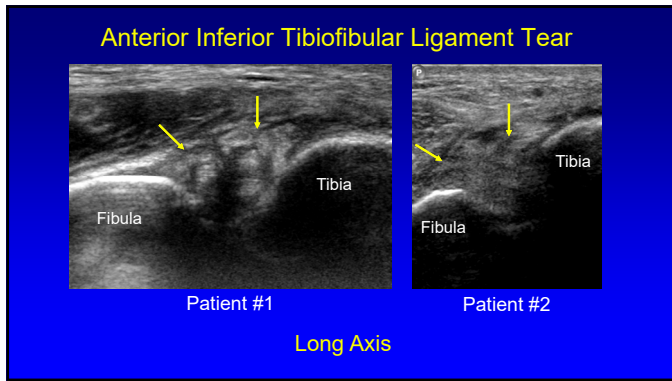


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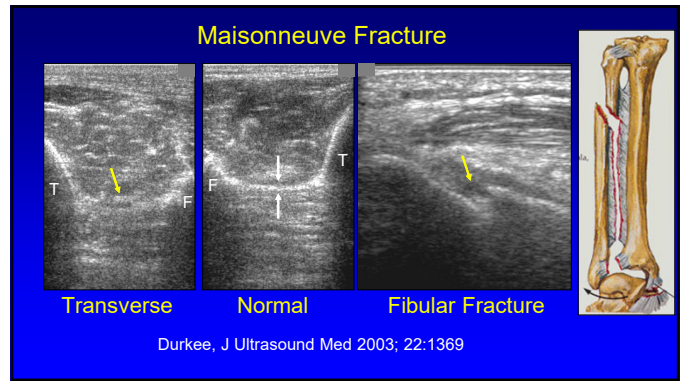
Calcaneofibular Ligament Tear



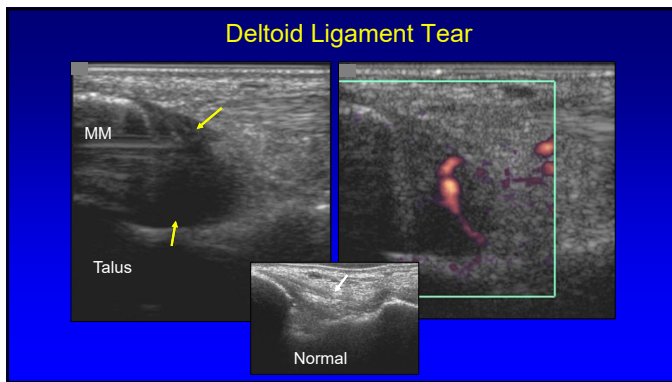
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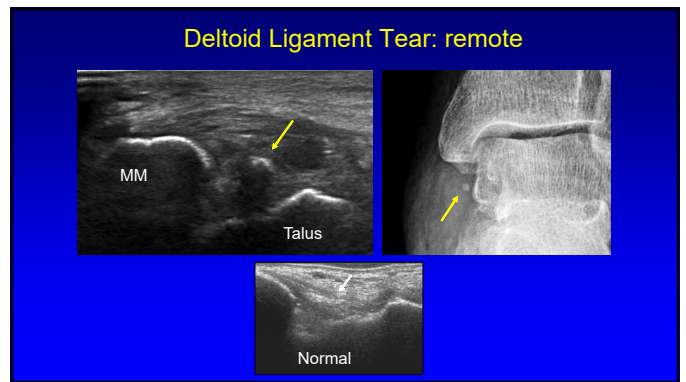
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Spring Ligament Complex

- Calcaneonavicular ligament
 - Superomedial
 - Perpendicular to distal PTT
 - Medioplantar oblique
 - Inferoplantar longitudinal

From: Radiology 2005; 237:242

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Superomedial Calcaneonavicular Ligament

- Associated with PTT dysfunction
- Abnormal: hypoechoic, thick > 4 mm, thinned or disrupted

Patient #1 Patient #2

Harish, J Ultrasound Med 2008; 27:1145

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Outline:

- Trauma:
 - Tendon, Ligament, **Bone**
- Infection and Inflammation
- Developmental Anomalies
- Tumors and Tumor-like Abnormalities

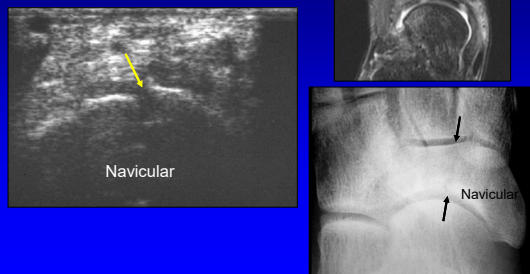
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Fatigue Fractures

- Navicular
 - Sagittal plane, cortical step-off
- Metatarsal shaft
 - Cortical step-off
 - Periostitis
 - Callus

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Stress Fracture: navicular



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Metatarsal Fatigue Fracture



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Outline:

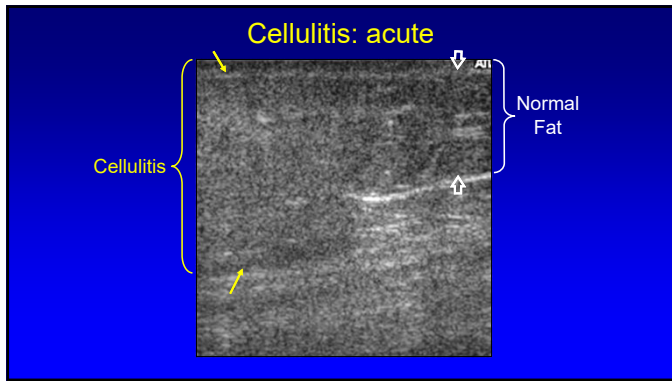
- Trauma:
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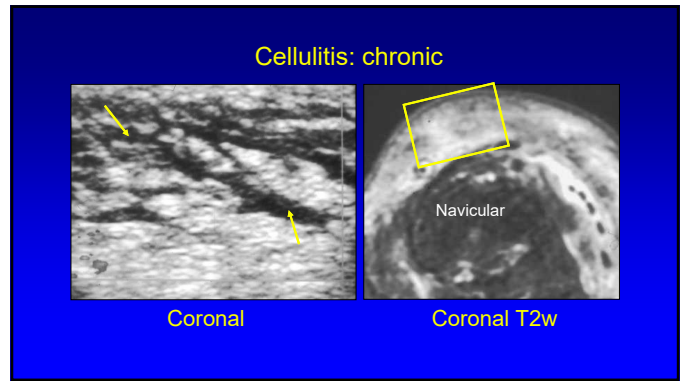
Infection: *predicted by route*

- Direct spread:
 - Ulceration (diabetic), penetrating injury
 - Soft tissue infection, osteomyelitis
- Hematogenous spread:
 - Children, intravenous drug abusers
 - Septic joint, osteomyelitis

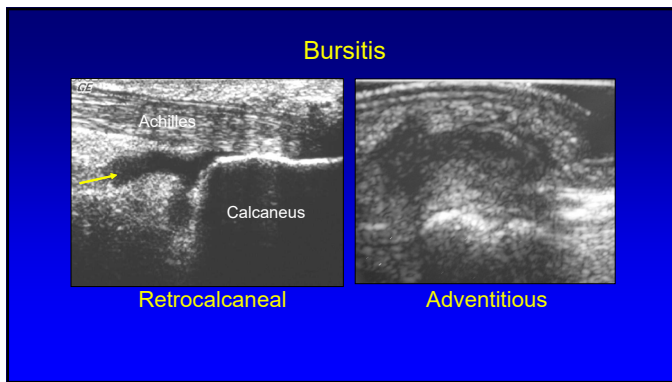
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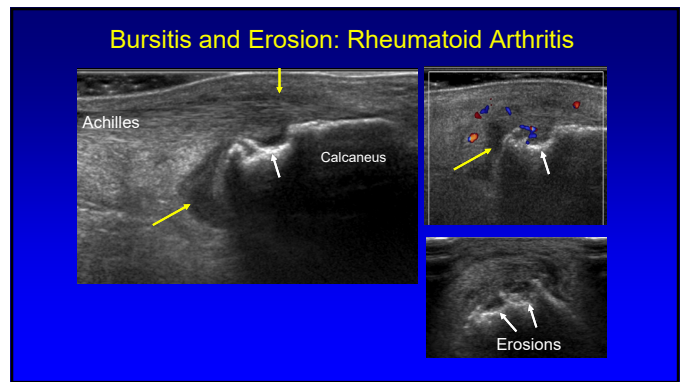
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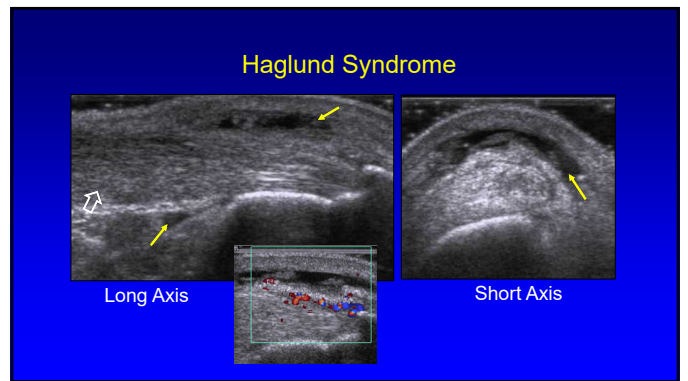


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Haglund Syndrome:

- Achilles abnormality
- Retrocalcaneal bursitis
- Superficial tendo-Achilles bursitis
- Enlarged posterior calcaneal tuberosity
– Correlate with radiography

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Septic Joint:

- Anechoic or hypoechoic distention of joint recesses
- May be hyperechoic if complicated
 - Possible synovitis
- US or color Doppler cannot distinguish between septic and aseptic effusion*

*Strouse et al. Radiology 1998; 206:731

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Effusion: tibiotalar joint

Tibia Talus Sagittal

Talus Axial

Aspiration

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5th Metatarsal Phalangeal Joint: septic

5th MT PP Sagittal

5th MT Coronal

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Inflammatory Arthritis:

- Non-specific findings:
 - Joint effusion
 - Enhancing synovitis
 - Erosions
- Rely on history and distribution of abnormalities

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Synovitis: color flow

Tibia Talus RA Ankle No flow

RA ankle Positive flow

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Rheumatoid Arthritis

5th MT Sagittal: dorsal

Sagittal: plantar lateral

Transverse

- 5th metatarsal head
 - Most common site for involvement
- Supplement dorsal evaluation with lateral and plantar view

Inanc N et al. US Bio Med 2016; 42:865

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Gout:

- Joint effusion / synovial hypertrophy
- Double contour sign:
 - Monosodium urate crystal icing on cartilage
- Tophi:
 - Hyperechoic with hypoechoic rim
- Erosions:
 - Adjacent to tophi
 - Medial 1st metatarsal head

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Tibiotalar Joint Effusion: gout

Tibia Talus
Sagittal Talus

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Gout: Double Contour Sign

Metatarsal Head Proximal Phalanx
1st MTP Joint Ankle Joint

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Tophi

- Hyperechoic heterogeneous with hypoechoic rim
- Tiny internal speckles*
- “wet clump of sugar” appearance
- Variable shadowing: even without calcification

MT PP

Fernandes et al. Skeletal Radiol 2011; 40:309

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Symptomatic Accessory Navicular

PTT Talus Acc. Nav. Navicular

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Peroneus Quartus

- Accessory tendon
- Present in 22%
- Origin: peroneus brevis muscle
- Insertion: retrotrochlear eminence of calcaneus

*Radiology 2001; 218:415

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Peroneus Quartus

Transverse

87

Outline:

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Ganglion

- Well-defined, lobular
- Multilocular
- Non-compressible
- Hypoechoic to anechoic
- Increased through-transmission
- Joint or tendon sheath communication

Ortega et al. AJR 2002; 178.1445

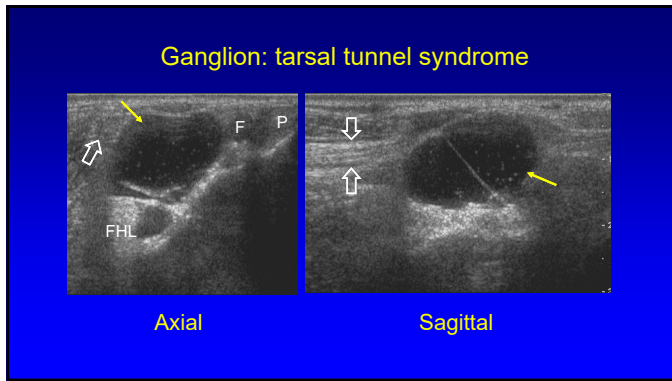
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Ganglion

Coronal T1W

Coronal T2W

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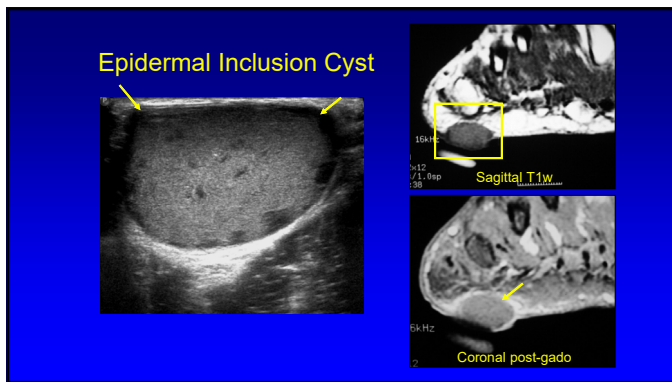
91

Epidermal Inclusion Cyst

- Not ruptured:
 - Hyperechoic, round to oval
 - Internal hypoechoic clefts: characteristic
 - Hyperechoic foci: keratin
 - Surrounding hypoechoic halo
 - Increased through-transmission
- Ruptured: irregular shape, no halo

Kim et al. Skeletal Radiol 2010; 40:1415

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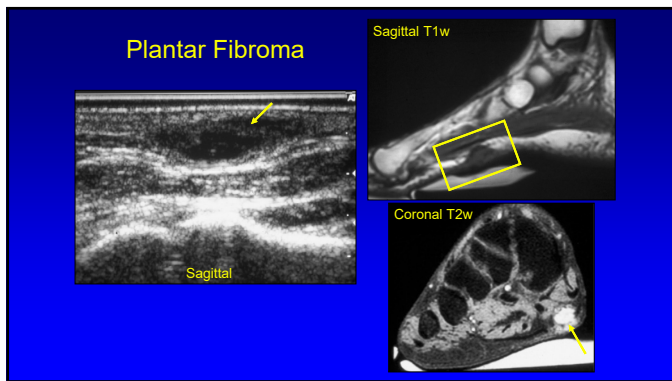
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Plantar Fibromatosis:

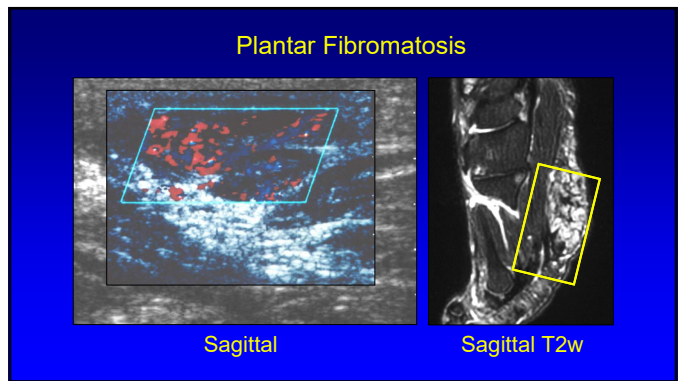
- Benign fibrous proliferation
- Multiple: 33%, bilateral: 20 – 50%
- Hypoechoic mass or masses
- Plantar aponeurosis
- Variable vascularity

Griffith JF et al. AJR 2002; 179:1167

94



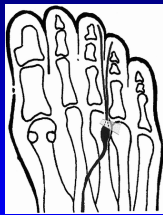
95



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Morton Neuroma:

- Interdigital nerve entrapment
- Edema, fibrosis, necrosis
- 3rd intermetatarsal space > 2nd
- Sharp, burning pain from metatarsal head to toes
- Females: pliable foot, high-heeled narrow-toed shoes



From: Martinoli, RadioGraphics 2000; 20:S199

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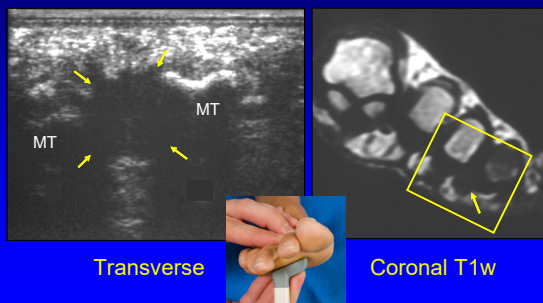
Morton Neuroma

- Hypoechoic 5 mm mass
 - Sensitivity: 100% ; Specificity: 83%
 - Accuracy equal to MRI
 - Nerve continuity: sagittal plane
- Intermetatarsal bursa
 - Associated with neuroma
 - “Neuroma-bursal complex”

Quinn T et al. AJR 2000; 174:1723
Bignotti B et al. Eur Radiol 2015; 25:2254
Cohen SL et al. J Ultrasound Med 2016; 25:3191

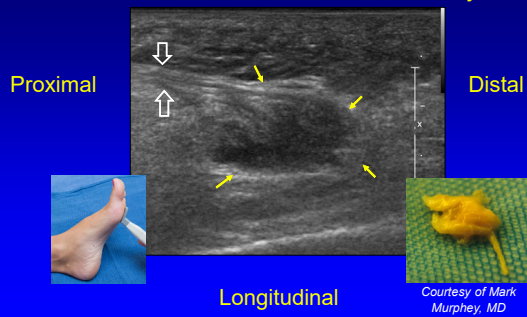
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Morton Neuroma



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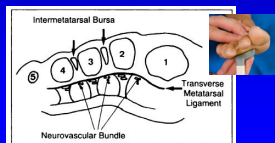
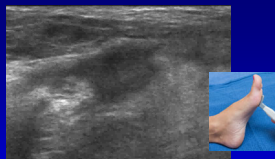
Morton Neuroma: nerve continuity



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Dynamic Evaluation

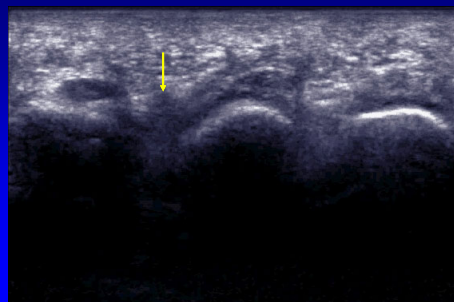
- Compression
 - Between transducer and palpation
 - Bursae (dorsal) compress, neuromas (plantar) do not
- Sonographic Mulder Sign
 - Scan plantar: coronal plane
 - Neuroma displaces: plantar
 - Palpable click



Torriani M et al. AJR 2003; 180:1121
Zanetti M et al. Radiology 1997; 203:516

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Dynamic imaging: Mulder's Maneuver



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Take Home Points

- Knowledge of anatomy is key
- Systematic approach
 - Develop routine, efficiency
 - Comfortable with normal structures
- Focus at site of symptoms
- Dynamic imaging

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Syllabus on line and additional educational material:
www.jacobsonmskus.com

Twitter handle: @jjacobsn

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